# NaWrapper

*Release 0.1*

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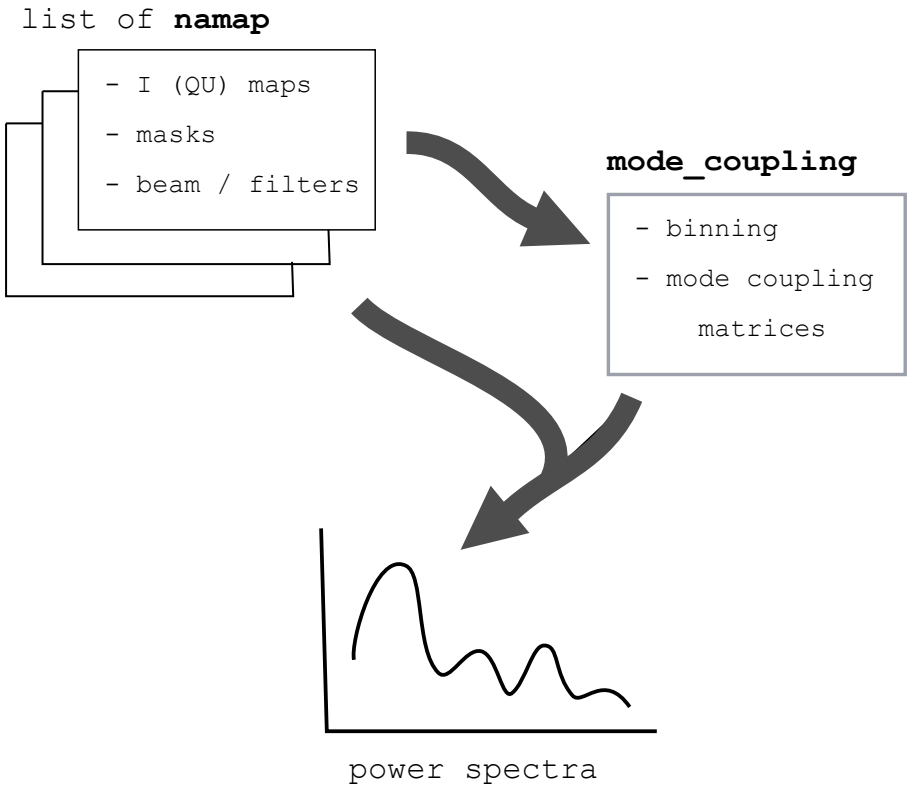
# CONTENTS

NaWrapper is a thin wrapper around NaMaster for CMB work in rectangular pixelization, in particular for the ACT experiment.




It bundles all the necessary pieces associated with a map (i.e. beams, masks, filters) into a `nawrapper.ps.namap` object, and provides concise utility functions for turning these into dictionaries of power spectra.

CHAPTER

ONE

# INSTALLATION

This guide is intended for people who are not currently using Anaconda on Niagara. If you already have a conda environment on Niagara which works with Jupyter, skip to below to the subsection titled "Installing the Power Spectrum Software".

## 1.1 Create a Conda Environment

You first need to get the Anaconda module and enter a custom environment.

```
module load anaconda3
```

Either enter your preferred conda environment with `source activate YOUR_ENV_NAME` if you already have one, or create a new one. I call my power spectrum conda environment `ps`, but you can name it something else if you want, just replace every mention of `ps` in the instructions below with your desired environment name.

```
conda create -n ps python=3
```

Enter your environment. This is what you will type every time you want to compute some spectra (and in your SLURM power spectrum jobs!).

```
conda activate ps
```

You will need to install some other necessary packages into your conda environment, if you just created it. Note that we are using `-n` to specify the conda environment!

```
conda install -n ps matplotlib cython numpy scipy astropy pillow
```

If you are running on a machine with Jupyter like cori or niagara, we also set up ipykernel so your conda environment shows up in Jupyter. You can do this on tiger too, but it's less convenient (see Jupyter on the Cluster).

```
conda install -n ps ipykernel
python -m ipykernel install --user \
    --name ps --display-name "Python 3 (ps)"
```

## 1.2 Installing Software

We now install the power spectrum software. Install NaMaster with

```
conda install -c conda-forge namaster -n ps
```

You must also install pixell if you do not have it. If you are on niagara, you will need to `module load autotools` to get autoconf first.

```
git clone git@github.com:simonsobs/pixell.git
cd pixell
python setup.py install --user
```

Then install nawrapper (my routines for ACT power spectrum analysis).

```
git clone git@github.com:xzackli/nawrapper.git
cd nawrapper
pip install -e . --user
```

You should be all set! Try out the `Getting Started.ipynb` in the `notebooks/` folder.

CHAPTER

TWO

# QUICKSTART

## 2.1 Simulated Maps

We start by importing our libraries.

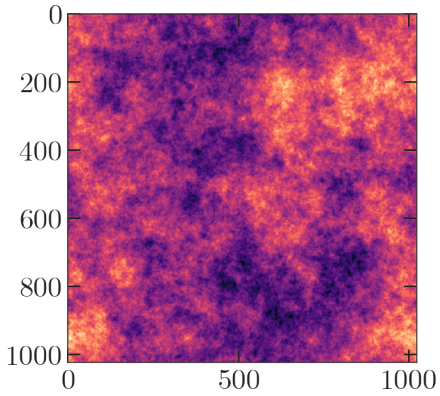
```
import nawrapper.ps as nw
import pymaster as nmt
import numpy as np
import matplotlib.pyplot as plt
from pixell import enmap, enplot
```

Next, we generate a random map realization for the spectrum $C_\ell = \ell^{-2.5}$.

```
# map information
shape,wcs = enmap.geometry(shape=(1024,1024),
    res=np.deg2rad(0.5/60.),pos=(0,0))

# create power spectrum information
ells = np.arange(0,6000,1)
ps = np.zeros(len(ells))
ps[1:] = 1/ells[1:]**2.5

# generate a realization
imap = enmap.rand_map(shape,wcs,ps[None,None])
plt.imshow(imap)
```



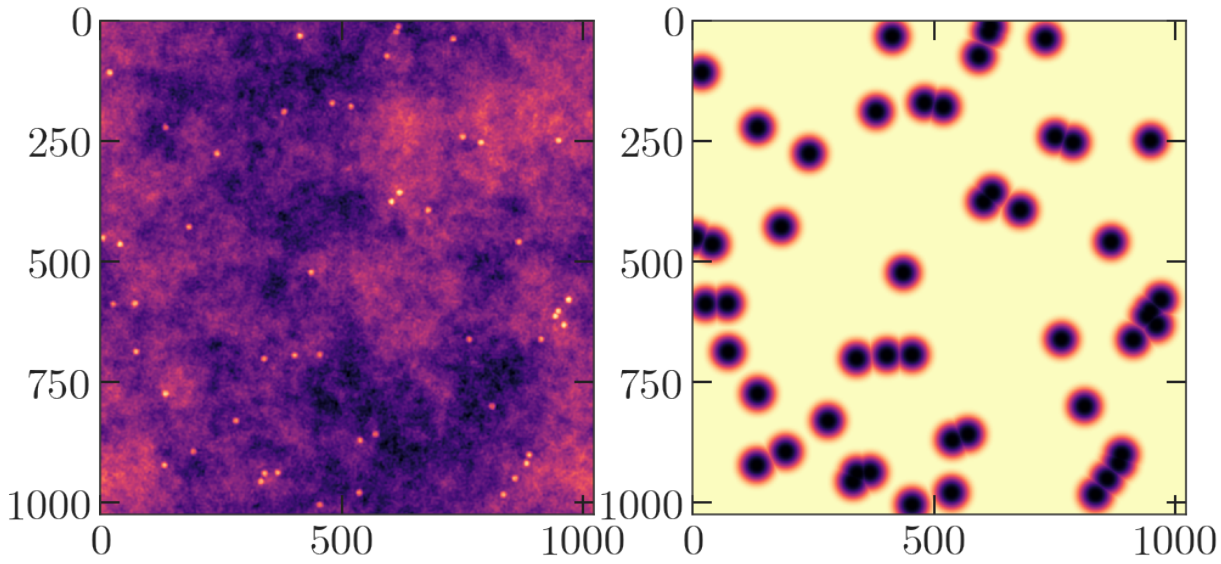

Next, we generate a fake point source map and a matching source mask.

```
mask = enmap.ones(imap.shape, imap.wcs)

N_point_sources = 50
for i in range(N_point_sources):
    mask[
        np.random.randint(low=0, high=mask.shape[0]),
        np.random.randint(low=0, high=mask.shape[1]) ] = 0
# apodize the pixels to make fake sources
point_source_map = 1-nw.apod_C2(mask, 0.1)

imap += point_source_map # add our sources to the map
mask = nw.apod_C2(mask, 0.5) # apodize the mask

# plot our cool results
fig, axes = plt.subplots(1, 2, figsize=(8,16))
axes[0].imshow(imap)
axes[1].imshow(mask)
```




For additional realism we generate noise power spectra to add to our "splits".

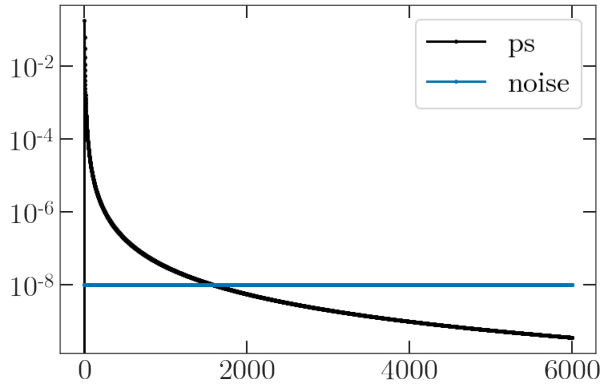
```
ells = np.arange(0,len(ps),1)
nl = np.ones(len(ells)) * 1e-8

noise_map_1 = enmap.rand_map(shape,wcs,nl[None,None])
noise_map_2 = enmap.rand_map(shape,wcs,nl[None,None])

plt.plot(ps, label="ps")
plt.plot(nl, label="noise")
plt.yscale('log')
plt.legend()
```

For this example, we won't include a beam. Now we set up the namap objects, adding our original random map to the noise realization.

```
namap_1 = nw.namap(map_I=imap + noise_map_1, mask=mask)
namap_2 = nw.namap(map_I=imap + noise_map_2, mask=mask)
```

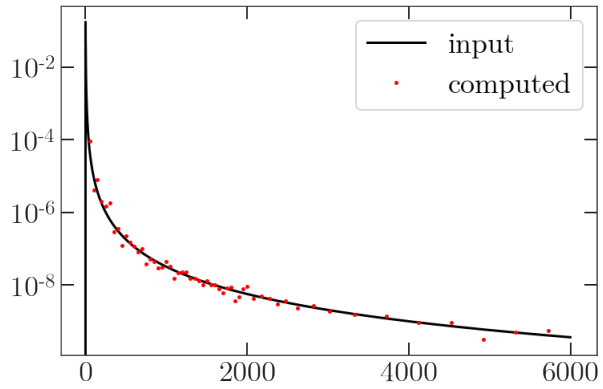



Next we compute the mode-coupling matrix. We need the binning file, which we store in *notebooks/data/*. You'll need to point it to the right path on your own installation.

```
binfile = 'data/BIN_ACTPOL_50_4_SC_low_ell'
bins = nw.read_bins(binfile)
mc = nw.mode_coupling(namap_1, namap_2, bins)
```

Finally, we can compute some spectra! Pass in the namaps we created, with the mode coupling object.

```
Cb = nw.compute_spectra(namap_1, namap_2, mc=mc)
```




We've recovered our input spectrum!

CHAPTER

THREE

# INDICES AND TABLES

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